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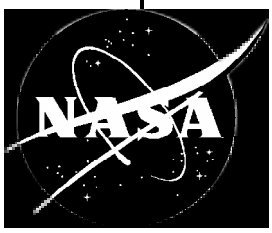
MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and the Flight Dynamics Division (FDD)

September 1997



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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Preface

This document is under the configuration management of the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division Configuration Control Board (CCB).

Proposed changes to this document shall be submitted to the Nascom CCB, along with supportive material justifying the change. Changes to this document shall be made by Document Change Notice (DCN) or by complete revision.

Questions concerning this document and proposed changes shall be addressed to:

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Abstract

This Interface Control Document (ICD) describes interface agreements between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and the Flight Dynamics Division (FDD).

Keywords: *EBnet, FDD, Flight Dynamics Division, ICD, interface control document*

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Abbreviations and Acronyms

Section 1. Introduction

1.1 Authority and Responsibility

The Mission Operations and Data Systems Directorate (MO&DSD) has the authority to implement the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet). This authority was granted to MO&DSD by the EOS project under the Office of Mission to Planet Earth (Code Y). The EBnet project is under the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division of the MO&DSD.

Code 540 will provide an operational communications network to support high-speed network communications between EBnet and non-EBnet hosts. The primary responsibility for this project has been assigned to the Nascom Division, Code 540. The system requirements are documented by the references in Section 2.1.

1.2 Purpose

The purpose of this document is to provide a detailed definition of the interface(s) between EBnet and the Flight Dynamics Facility (FDF) in Building 28 and between the Flight Dynamics Division (FDD) equipment located at the EOSDIS Operations Center (EOC).

1.3 Scope

This document defines and specifies the data transport interfaces (i.e., protocols, standards applied, physical connections, and locations connected) between EBnet and the FDD equipment at the EOC.

1.4 Time Frame

This Interface Control Document (ICD) shall be in effect from the date of the last approval signature.

1.5 Goals and Objectives

The goals of EBnet are to:

a. Implement an operational, integrated, transparent communications system that serves the data communications needs of projects supported by NASA Goddard Space Flight Center (GSFC), and users outside the MO&DSD.

b. Expand using industry standard system solutions while maintaining compatibility with the existing network and user interfaces.

c. Minimize costs for implementation, operation, and maintenance of the network.

d. Minimize life-cycle costs.

e. Maintain high availability by designing with redundancy, and without single points of failure in the Network Backbone, where required.

f. Utilize state-of-the-art technology, utilizing equipment with the best price-performance available commercially.

g. Allow for growth, adaptability to changing requirements, infusion of new technology, and upgraded interfaces throughout the life-cycle.

1.6 Standards Precedence

EBnet will be based on Government, commercial, and international standards. In case of conflict, the following precedence (in descending order) applies:

- This EBnet ICD.
- Government standards.
- Commercial and/or international standards.

1.7 Document Organization

Section 2 contains parent, applicable, and reference documents related to this ICD.

Section 3 details a systems overview of the EBnet, FDF and the interrelationship.

Section 4 presents an interface detailed design.

Section 5 describes the facilities and maintenance demarcation.

A list of abbreviations and acronyms is provided at the end of the document.

Section 2. Related Documentation

2.1 Parent Documents

[1] *Earth Observing System AM-1 Detailed Mission Requirements*, Goddard Space Flight Center (GSFC), 505-10-33, November 1996

[2] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 6, EOSDIS Backbone Network (EBnet) Requirements*, Goddard Space Flight Center (GSFC) 505-10-01-6, Revision A, December 1996

[3] *Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) Interface Requirements Document (IRD)*, September 1997

[4] Reserved

2.2 Applicable Documents

[5] *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*, Electronic Industries Association (EIA) 422-A, December 1978

[6] *General-Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, EIA 449, November 1977

[7] *Internet Protocol (IP): DARPA Internet Program Protocol Specification*, Request for Comment (RFC) 791, September 1981

[8] *The Point-to-Point Protocol (PPP)*, RFC 1661, July 1995

[9] *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48-bit Ethernet Addresses for Transmission on Ethernet Hardware*, RFC 826, November 1982

[10] *Internet Control Message Protocol*, RFC 792, September 1981

[11] *Routing Information Protocol (RIP)*, RFC 1058

[12] *Open Shortest Path First (OSPF)*, RFC 1247

[13] *Internet Group Multicast Protocol (IGMP)*, RFC 1112

[14] *On the Assignment of Subnet Numbers*, RFC 1219

[15] *Simple Network Management Protocol (SNMP)*, RFC 1157

[16] *Address Resolution Protocol (ARP)*, RFC 826

[17] *A Reverse Address Resolution Protocol (RARP)*, RFC 903

[18] *Internet Protocol on Ethernet Networks*, RFC 894

[19] *Transmission of IP over FDDI*, RFC 1188

[20] *Structure of Management Information*, RFC 1155

[21] *Management Information Base - II*, RFC 1213

[22] *Transmission Control Protocol*, RFC 793

[23] *Telnet Protocol*, RFCs 854 & 855

[24] *File Transfer Protocol*, RFC 959

[25] International Organization for Standardization (ISO) 9314-1, *FDDI Physical Layer Protocol (PHY)*

[26] ISO 9314-2, *FDDI Media Access Control (MAC) Protocol*

[27] ISO 9314-3, *FDDI Physical Layer Medium Dependent (PMD)*

[28] ISO 8802-2, *Logical Link Control (LLC)*

[29] ISO 8802-3, *Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet version 2*

[30] Institute of Electrical and Electronic Engineers (IEEE) 802.3 *10Base-T (twisted pair)*

[31] IEEE *10Base5 (thick ethernet)*

[32] International Telegraph and Telephone Consultative Committee (CCITT) *V.35*

2.3 Reference Documents

[33] *NASA Communications (Nascom) Access Protection Policy and Guidelines*, 541-107, Revision 3, GSFC, November 1995

[34] *NASA Communications System Acquisition and Management*, NASA Management Instruction (NMI) 2520.1D, National Aeronautics and Space Administration (NASA), November 18, 1991

[35] *Nascom IONET Users Guide*, 541-225, Revision 1, April 1996

Section 3. Systems Overview

3.1 EBnet General System Description

The EBnet provides wide-area communications circuits and facilities between and among various EOS Ground System (EGS) elements to support mission operations and to transport mission data between EOSDIS elements. The relationship of EBnet to other elements supporting EOS is shown in Figure 3-1. EBnet is responsible for transporting spacecraft command, control, and science data nationwide on a continuous basis, 24 hours a day, 7 days a week. The EBnet capability to transport these diverse types of data is implemented as two distinct subnetworks referred to as "real-time" and "science" networks. The real-time network transports mission-critical data related to the health and safety of on-orbit space systems and raw science telemetry, as well as prelaunch testing and launch support. This highly redundant network provides an operational availability of 0.9998 with a Mean Time to Restore Service (MTTRS) of 1 minute. The science network transports data including Expedited Data Sets (EDSs), Production Data Sets (PDSs), and rate-buffered science data. The science network provides an operational availability of 0.98 with an MTTRS of 4 hours.

EBnet provides three options for accessing the Internet Protocol (IP)-based transport service: Local Area Network (LAN) Ethernet, LAN Fiber Distributed Data Interface (FDDI), and Wide Area Network (WAN) carrier service. Figure 3-2 shows an example of each of these types of interface/demarcation points to EBnet users. This ICD describes the EBnet–FDF interface that uses the LAN interface type.

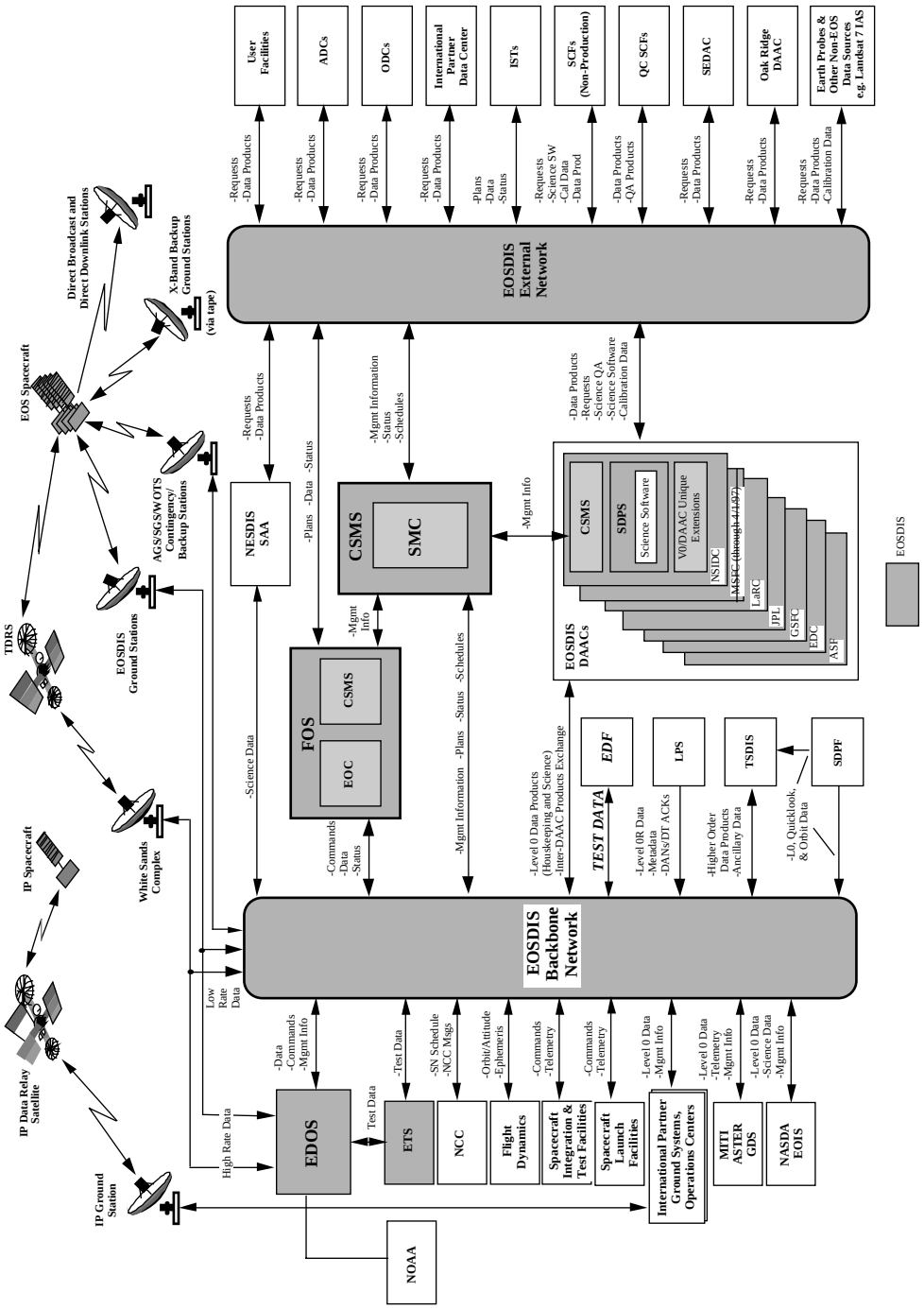

Figure 3-1. EOS Ground System

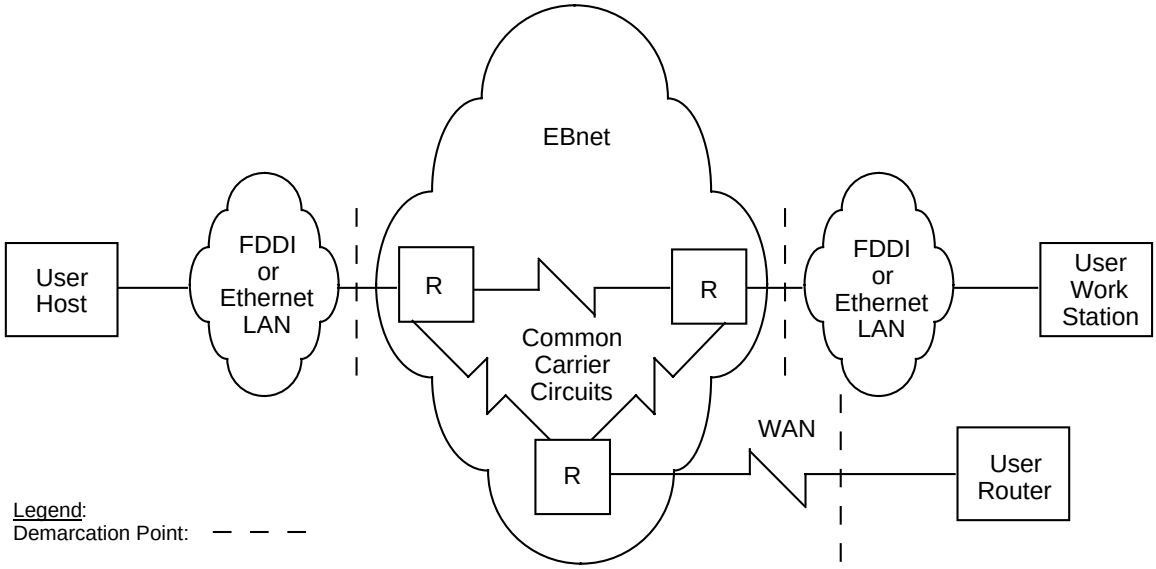

Figure 3-2. EBnet Demarcations

Sustaining engineering, preventive and remedial maintenance, and network monitoring services are provided for EBnet equipment, to ensure that EBnet keeps pace with technology and standards, and provides continuous service. The official point of contact for EBnet operational status is the Nascom Communications Manager (COMMGR) (301-286-6141). Users who detect a network problem are urged to immediately report it to the COMMGR. The COMMGR may also provide users with limited information about maintenance and status actions. Refer to the Nascom IP Operational Network (IONET) User Guide (541-225) for information regarding user connections, security guidelines, and maintenance information.

3.2 FDD Description

Most Flight Dynamics support (maneuver planning, attitude estimation, product generation, and TONS performance evaluation/quality assurance) for EOS AM-1 will be provided from the EOC facility in Building 32 using a set of workstations with their associative FDD software, collectively called the Flight Dynamics System (FDS). The FDS consists of two Sun workstations, two Hewlett-Packard (HP) workstations, and two Pentium Pro machines. Three machines (one Sun, one HP, and one PC) will be referred to as the primary set of machines and will exist on a LAN separate from the EOC LAN. The other set will be the backup machines, which will reside on another LAN separate from the primary machines. This gives the FDS environment full redundancy. All workstations will interface with the EOC LAN to exchange products and services. In addition, the Orbit system is supplemented by an EOC-supplied workstation used to provide realtime telemetry displays.

Certain types of support require institutional services, which for various reasons cannot or will not be provided by the FDS in the EOC. These Service Level Agreement (SLA) services are provided to the FDS from the Flight Dynamics Facility (FDF) in building 28 via FDF's closed LAN. The FDF's closed LAN, as shown in Figure 3-3, is part of the hardware and software system of the Flight Dynamics Division (FDD), which provides support to flight projects and tracking networks. This support includes orbit determination and prediction, and tracking system metric data evaluation. The FDF's closed LAN also provides connectivity between the PCs, printers, and file servers, located within Building 28 and with other FDD hardware and software systems.

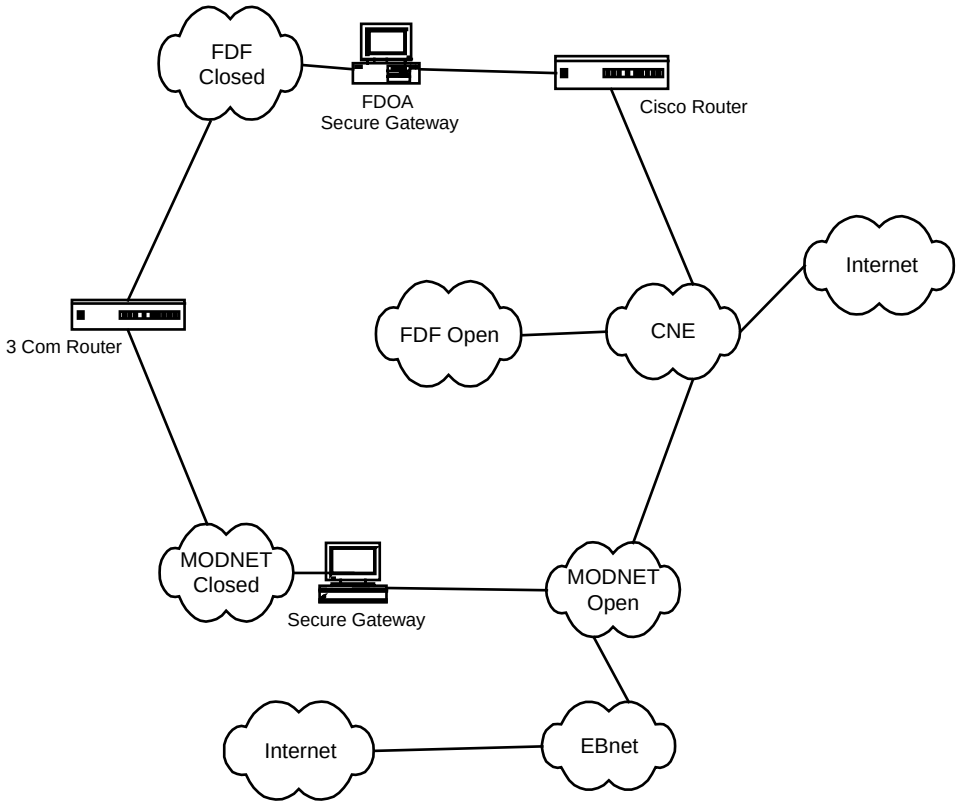

Figure 3-3. FDOA Network Connectivity

3.3 Relationship Between EBnet and FDD

The purpose of the interface between the FDD and EBnet is to support connectivity between the FDD closed LAN in Building 28 and the FDD equipment located in the EOC within Building 32. All data traffic between the FDF closed LAN and the EOC supported by EBnet will be classified as science traffic. (For purposes of EBnet ICDs, any traffic that is not real time is considered science traffic.) In addition to supporting connectivity to the FDF closed LAN in Building 28, the FDD equipment in the EOC

within Building 32 will require Internet connectivity which will be established from the EOC as shown in Figure 4-1.

Section 4. Interface Detailed Design

4.1 Interface Design Overview

The EBnet GSFC site design shown in Figure 4-1 demonstrates the connectivity from the FDD closed LAN in Building 28 to the FDD equipment located in the EOC within Building 32. The FDD closed LAN in Building 28 will utilize its existing connection to the MO&DSD Operational/Development Network (MODNET)/Nascom Operational Local Area Network (NOLAN) LAN in Building 1 to establish connectivity to the EBnet FDDI router for the primary FDD machines.

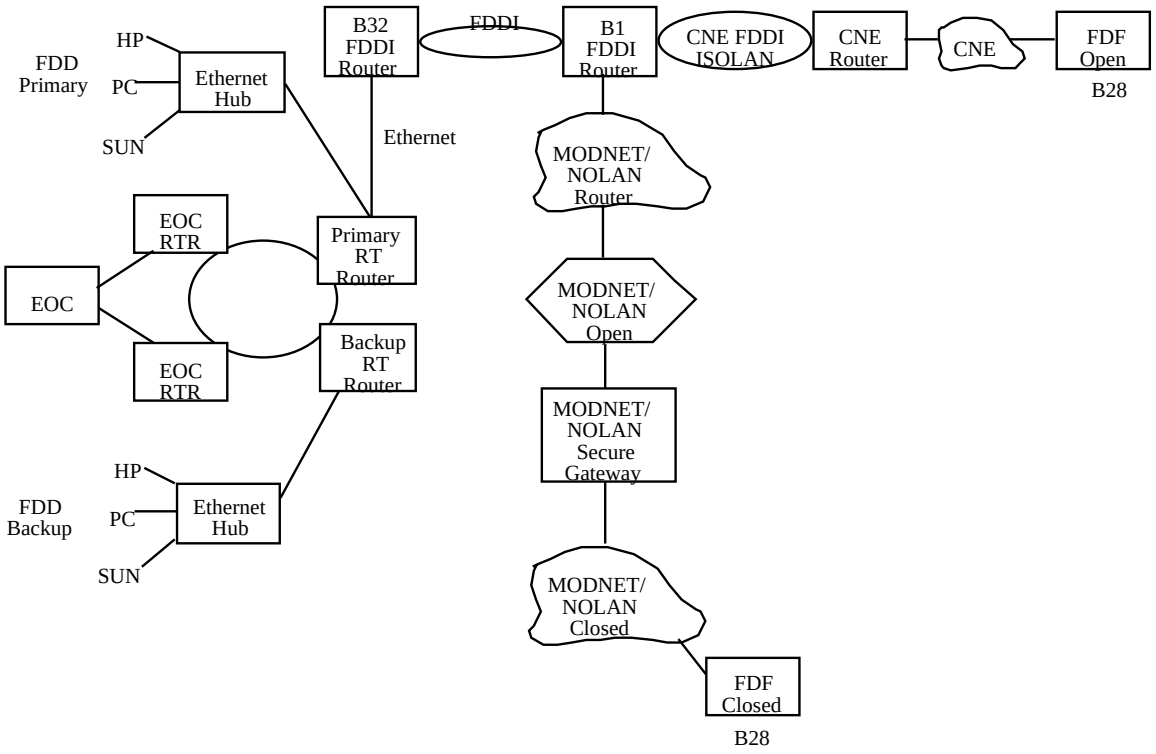

Figure 4-1. GSFC Site Design EBnet–FDD at EOC

4.2 Design Assumptions

The FDF closed LAN in Building 28 will coordinate with MODNET/NOLAN to establish connectivity through the closed portion of MODNET.

4.3 Data Interface Design

The data interface design provides the communications between the FDF closed LAN and the FDD equipment located at the EOC. EBnet supplies two FDDI routers with Ethernet connectivity that provides intelligent switching and routing for various interconnections. These routers are capable of providing protocol-based routing and filtering, while providing excellent bandwidth and IP multicasting capability. The EBnet to FDD interface at the EOC, as shown in Figure 4-1, consists of the six user interfaces connected via 10 Base-T to two separate Ethernet Hubs. The following paragraphs describe the protocols used for each ISO layer for this interface.

4.3.1 ISO Layer One Interface Control (Physical Layer)

The FDD equipment at the EOC shall use the 10 Base-T physical interface and it will be the responsibility of the FDF to provide all cabling required to connect the workstations to the Ethernet Hub.

EBnet will support the following physical layer connections:

a. IEEE 802.3, 10 Base-T (unshielded twisted pair) with RJ-45 connectors.

4.3.2 ISO Layer Two Interface Control (Data Link Layer)

EBnet will support the following data link interfaces:

a. ISO 802.2, Logical Link Control (LLC).

b. ISO 8802-3, Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet Version 2.0 is supported.

c. ISO 9314-2, FDDI MAC Protocol.

4.3.3 ISO Layer Three Interface Control (Network Layer)

The FDD to EBnet interface shall conform to the entire suite of IP specifications, including Request for Comments (RFC) 791 [7], RFC 792 [10], and RFC 826 [16] for Internet Protocol, Internet Control Message Protocol (ICMP), and Ethernet Address Resolution Protocol (ARP), respectively.

EBnet will support the following network layer protocols:

a. RFC 791, Internet Protocol Version 4.0.

b. RFC 826, ARP.

c. RFC 903, Reverse Address Resolution Protocol (RARP).

d. RFC 1058, Routing Information Protocol (RIP).

e. RFC 1247, Open Shortest Path First (OSPF).

4.3.4 Upper-Layer Protocols

EBnet will support transparent communications for upper-layer protocols.

4.4 Routing and Addressing Guidelines

EBnet will be internetworked by routers and switches which will be configured to support only the IP, and will provide isolation for separate networks. EBnet will utilize standard IP addressing conventions. EBnet will provide the following Class C addresses: 198.118.197.160-175 for the primary FDD workstations and 198.118.197.XXX for the backup workstations.

4.5 Data Flow Requirements

The EBnet–FDF interface will support up to 1 megabit per second (Mbps) of data throughput capability.

4.6 Equipment List

EBnet will provide the following equipment to support this interface:

a. Router: Cisco (Model 7513).

b. Ethernet Hub: Cabletron (Model SEHI -24).

c. Router: Cisco (Model 7206).

Section 5. Facilities and Maintenance Demarcation

5.1 Equipment Location

The EBnet Cisco 7513 router is located at GSFC at the EOC in Building 32, Room C210H. The EOC will provide two rack spaces for EBnet racks housing the routers and the Ethernet hub as shown in Figure 5-1.

5.2 Maintenance Demarcation

The point of demarcation for the FDD equipment located at the EOC shall be the EBnet Ethernet hub. The FDD shall be responsible for provisioning all cabling and necessary hardware to connect the required workstations to the Cabletron Ethernet hub.

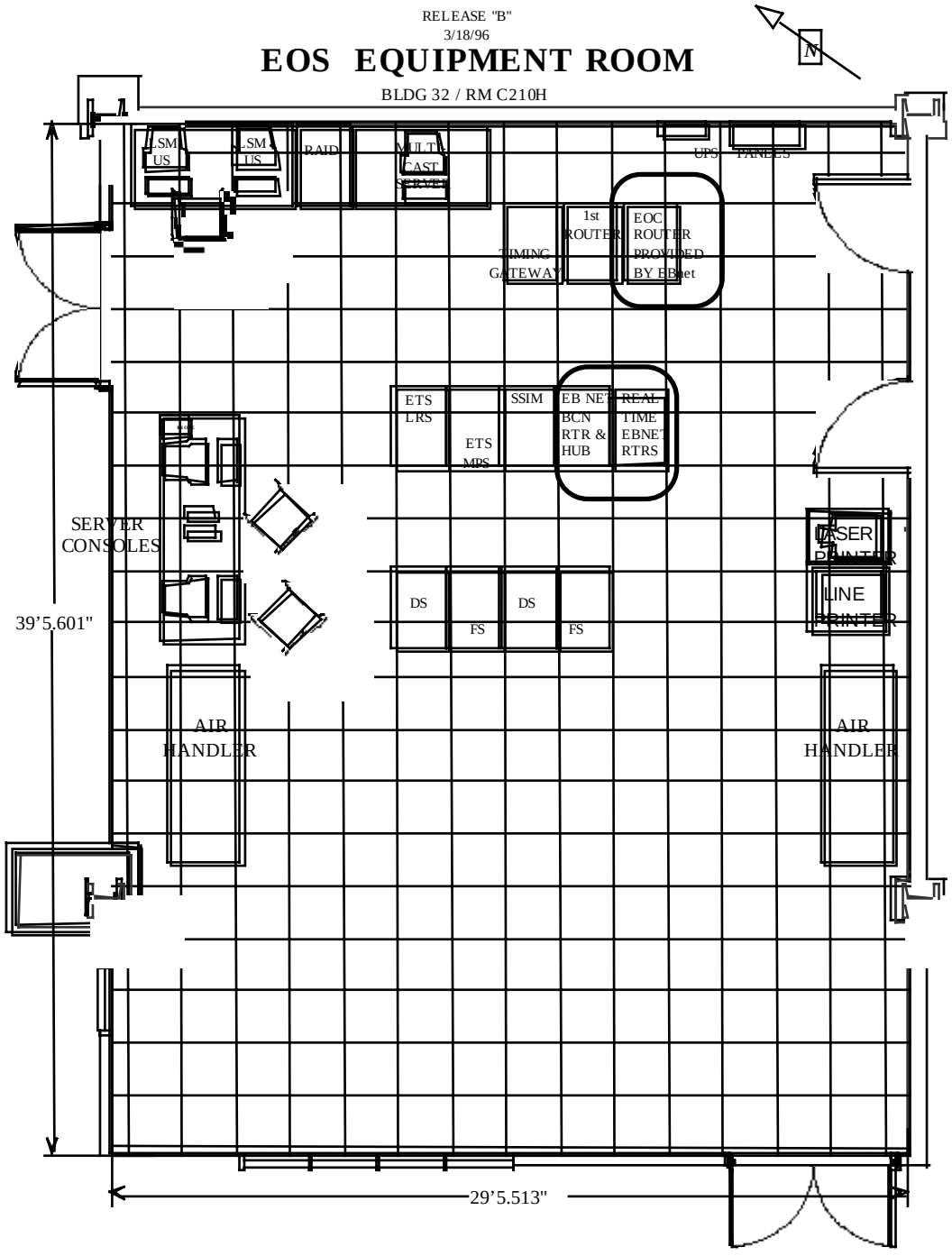

Figure 5-1. EOC Equipment Room Layout

Appendix A. FDD Interfaces Provided by EBnet Project

Table A-1 shows the FDD interfaces to various other components of the EOS AM-1 mission. Below is a summary of the primary functions with each organization.

Table A-1. FDD Interfaces

Component	Functional Description
Network Control Center (NCC)	Flight Dynamics System (FDS) provides acquisition data to NCC.
GSFC Distributed Active Archive Center (DAAC)	FDS supplies definitive attitude data to DAAC.
Instrument Support Toolkit (IST)	Provides capability to generate telemetry displays identical to those in EOC, and provides FDS applications direct access to decommutated telemetry data.
Flight Operations Team (FOT)	FDS sends some planning products directly to FOT-provided systems for their own use (i.e., without going through or using the FOS software).
EOC	FDS sends some planning products directly to the EOC and provides table load parameters to the EOC for subsequent building/uplinking of flight table loads. Products generated at intervals as selected by user and automatically transferred to EOC via File Transfer Protocol (FTP).

Abbreviations and Acronyms

ARP	Address Resolution Protocol
CCB	Configuration Control Board
CCITT	International Telegraph and Telephone Consultative Committee
CSMA/CD	Carrier-Sense Multiple-Access with Collision Detection
DAAC	Distributed Active Archive Center
DCN	Document Change Notice
EBnet	EOSDIS Backbone Network
EDS	Expedited Data Set
EGS	EOS Ground System
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
FDD	Flight Dynamics Division
FDDI	Fiber Distributed Data Interface
FDF	Flight Dynamics Facility
FDOA	Flight Dynamics Operational Area
FDS	Flight Dynamics System
FOT	Flight Operations Team
FTP	File Transfer Protocol
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organization for Standardization
IST	Instrument Support Toolkit
LAN	Local Area Network
LLC	Logical Link Control
MAC	Media Access Control

Mbps	megabits per second
MO&DSD	Mission Operations and Data Systems Directorate
MODNET	MO&DSD Operational/Development Network
MTTRS	Mean Time to Restore Service
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NCC	Network Control Center
NOLAN	Nascom Operational Local Area Network
OSPF	Open Shortest Path First
PDS	Production Data Set
RARP	Reverse Address Resolution Protocol
RIP	Routing Information Protocol
SLA	Service Level Agreement
WAN	Wide Area Network